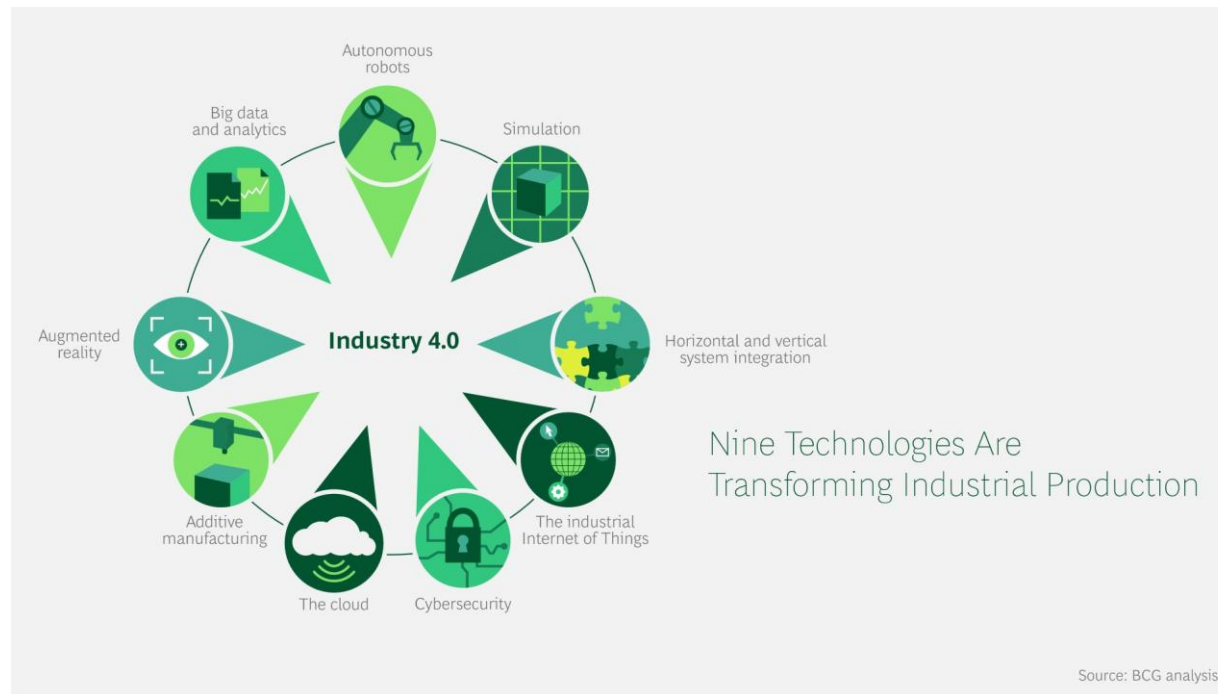


Study of teaching methodology and curriculum in relation to Industry 4.0

HEIn4

Advanced digital technology is already used in manufacturing, but with Industry 4.0, it will transform production. It will lead to greater efficiencies and change traditional production relationships among suppliers, producers, and customers — as well as between human and machine. Nine technology trends form the building blocks of Industry 4.0. (Source: BCG analysis).



1. BIG DATA AND ANALYTICS
2. AUTONOMOUS ROBOTS

3. SIMULATION
4. HORIZONTAL AND VERTICAL SYSTEM INTEGRATION
5. THE INDUSTRIAL INTERNET OF THINGS
6. CYBERSECURITY
7. THE CLOUD
8. ADDITIVE MANUFACTURING
9. AUGMENTED REALITY

We have selected the curricula of the three European universities, Katholieke Universiteit Leuven (KUL), Kungliga Tekniska högskolan (KTH), Instituto Politécnico do Porto (IPP), that offer masters degrees in the programs that fall into the above mentioned nine directions.

EU University	Number of MSC Programs
Katholieke Universiteit Leuven (KUL)	7
Kungliga Tekniska högskolan (KTH)	12
Instituto Politécnico do Porto (IPP)	10

Katholieke Universiteit Leuven	
Faculty of Economics and Business	
<ul style="list-style-type: none"> ▪ Master of Business Engineering ▪ Master of Business and Information Systems Engineering 	
Faculty of Engineering Science (Master's)	
<ul style="list-style-type: none"> ▪ Master of Engineering: Computer Science ▪ Master of Electrical Engineering 	
Faculty of Engineering Science (Advanced Master's)	
<ul style="list-style-type: none"> ▪ Master of Artificial Intelligence 	
Faculty of Engineering Technology	
<ul style="list-style-type: none"> ▪ Master of Electromechanical Engineering Technology ▪ Master of Electronics and ICT Engineering Technology 	

Kungliga Tekniska högskolan

School of Electrical Engineering and Computer Science

- Communication Systems
- Computer Science
- Embedded Systems
- ICT Innovation
- Information and Network Engineering
- Machine Learning
- Security and Cloud Computing (Joint Erasmus+)
- Software Engineering of Distributed Systems
- Systems, Control and Robotics

School of Industrial Engineering and Management

- Engineering Design
- Industrial Management
- Production Engineering and Management

P.Porto

ISEP PORTO SCHOOL OF ENGINEERING

- Master in Electrical and Computer Engineering - Automation and Systems
- Master in Electrical and Computer Engineering - Autonomous Systems
- Master in Electrical and Computer Engineering - Systems and Industry Planning
- Master in Electrical and Computer Engineering - Telecommunications
- Master in Informatics Engineering - Computer Systems
- Master in Informatics Engineering - Graphics Systems and Multimedia
- Master in Informatics Engineering - Information and Knowledge Systems
- Master in Informatics Engineering - Software Engineering
- Master in Mechanical Engineering - Industrial Management

ESTG SCHOOL OF MANAGEMENT AND TECHNOLOGY

- Master in Informatics Engineering

University	Master's degree program Courses under the Industry 4.0 thematic Katholieke Universiteit Leuven								
	Big data and analytics	Autonomous Robots	Simulation	Horizontal and vertical system integration	The industrial internet of things	Cybersecurity	The cloud	Additive manufacturing	Augmented reality
KUL Master of Business Engineering			Business Forecasting Data Mining	Business Analysis Applications of Operations Research and Statistics Quality Management Innovation Management Interdisciplinary Lab: Strategy, Innovation and Entrepreneurship					
Teaching methods									
KUL Master of Business and Information Systems Engineering	Machine Learning and Inductive Inference Data Mining Advanced Time Series Analysis Data Visualisation Analysis of Large Scale Social		Architecture and Modelling of Management Information Systems Simulation Theory and Applications Statistical Modelling	Advanced Database Management and Content Management Software Architectures for Collaborative Systems	Distributed Systems	Security of Network and Computer Infrastructure			Computer Vision

KUL Master of Artificial Intelligence	Privacy and Big Data Philosophy of Mind and Artificial Intelligence Machine Learning and Inductive Inference Artificial Neural Networks and Deep Learning								
Teaching methods									
KUL Master of Electromechanical Engineering Technology		Advanced Automation Drive Systems Dynamic Aspects of Machine Construction Robotics and Advanced Instrumentation Autonomous Vehicles	Computer-Aided Modelling and Simulation		Embedded Control Systems			Advanced Manufacturing Computer-Integrated Manufacturing Manufacturing Optimisation and Dimensional Quality Control Vehicle Design and Technology	
Teaching methods									
KUL Master of Electronics and	Machine Learning			Pathways to Sustainability: Core Issues and	Hardware Design			R&D Experience	

ICT Engineering Technology				Challenges	Distributed Applications				
Teaching methods									

	Master's degree program Courses under the Industry 4.0 thematic								
	Kungliga Tekniska högskolan (KTH)								
	Big data and analytics	Autonomous Robots	Simulation	Horizontal and vertical system integration	The industrial internet of things	Cybersecurity	The cloud	Additive manufacturing	Augmented reality
KTH Master of Electronics and ICT Engineering Technology					Mobile Networks and Services (IK2560) 7.5 credits <u>Advanced Internetworking II (IK2217) 7.5 credits</u> Wireless Communication Systems (IK2507) 7.5 credits Wireless Transmission Techniques (IK2508) 7.5 credits Communication System	<u>Internet Security and Privacy (IK2206)</u> Advanced Internetworking (IK2215) 7.5 credits Building Networked Systems Security (EP2520)			

					Design (IK2200)				
					Communication System Design (IK2200) 15.0 credits				
					Communication System Design (IK2200) 15.0 credits				
Teaching methods									
KTH Computer Science	<u>Artificial Intelligence (DD2380)</u> 6.0 credits Machine Learning (DD2421) 7.5 credits Deep Learning in Data Science (DD2424) 7.5 credits Artificial Neural Networks and Deep Architectures	Introduction to Robotics (DD2410)			Dependable Autonomous Systems (DD2528)	<u>Computer Security (DD2395)</u> 6.0 credits Software Safety and Security (DD2460) Building Networked Systems Security (EP2520) <u>Security Analysis of Large-Scale Computer Systems (EP2790)</u> Hardware Security (IL1333) <u>Software Safety and Security (DD2460)</u> Advanced Networked	<u>Automated Software Testing and DevOps (DD2482)</u>	Information Visualization (DH2321) Computer Graphics and Interaction (DH2323) Advanced Graphics and Interaction (DH2413) Computer Game Design (DH2650) Computer Game Design (DH2650) Human Perception for Information Technology (DM2350) Computational	

						Systems Security (EP2510) Ethical Hacking (EN2720)			Photography <u>Applied GPU Programming (DD2360)</u>
Teaching methods									
KTH Embedded Systems		Embedded Systems (IL2206) <u>Electronic Systems Design (IL2237)</u> <u>Embedded Hardware Design in ASIC and FPGA (IL2225)</u> Digital Design and Validation using Hardware Description Languages (IL2203) Hands-On Microelectromechanical Systems Engineering (EK2360) Project Course in Robotics and Autonomous Systems (DD2419)		Product Realization Processes I (II2300) 7.5 credits	Sensor Based Systems (II2302) Fundamentals of Integrated Electronics (IL2238) RFID Systems (IS2500) Distributed Systems, Basic Course (ID2201)	Advanced Networked Systems Security (EP2510) 7.5 credits			
Teaching methods									
KTH ICT INNOVATIONS	<u>Analysis and Search of Visual Data (EQ2425)</u> <u>Data Mining (ID2222)</u>	Introduction to Robotics (DD2410)	Modelling of Dynamical Systems (EL2820)	Technology-based Entrepreneurship (ME2062) e-Business Strategies (ME2095) <u>Entrepreneur</u>	Hybrid and Embedded Control Systems (EL2450) Control Theory and Practice, Advanced Course (EL2520)	<u>Networked Systems Security (EP2500)</u>	Advanced Internetworking (IK2215) Management of Networks and Networked Systems (EP2300)		Interaction Design Methods (DH2628) Human-Computer Interaction, Research Seminars (DH2632)

				<u>ship for Engineers (ME2072)</u> Business Development Lab of Entrepreneurship Engineers (ME2073)	<u>Cyber-Physical Networking (EQ2871)</u> Sensor Based Systems (II2302) Wireless Networks (EP2950) Ubiquitous Computing (ID2012) Mobile Networks and Services (IK2560)		Network Analytics (EP2420)		Interaction Programming and the Dynamic Web (DH2642) <u>Haptics, Tactile and Tangible Interaction (DH2670)</u> Multimodal Interaction and Interfaces (DT2140) Developing Mobile Applications (ID2216) Image and Video Processing (EQ2330) <u>Analysis and Search of Visual Data (EQ2425)</u>
Teaching methods									
KTH Information and Network Engineering	Machine Learning, Advanced Course (DD2434) Machine Learning and Data Science (EQ2415)			<u>Theory and Methodology of Science with Applications (Natural and Technological Science) (AK2036)</u> IT	Applied Antenna Theory (EI2400) Queuing Theory and Teletraffic Systems (EP2200)	Building Networked Systems Security (EP2520)			Project in Multimedia Processing and Analysis (EQ2445)

				<p>Management with Enterprise Architecture I (EH2770)</p> <p>Industrial Management , Basic Course (ME1003)</p> <p>The Sustainable Information and Network Engineer (EQ2222)</p> <p>Leadership in Cross-Cultural and Industrial Contexts (ME2089)</p>	<p>Principles of Wireless Sensor Networks (EP2700)</p> <p>Wireless Networks (EP2950)</p> <p>Network Programming (ID1212)</p> <p>Software Defined Networking (SDN) and Network Functions Virtualization (NFV) (IK2220)</p>				
Teaching methods									
KTH Information and Network Engineering	<p>Machine Learning, Advanced Course (DD2434)</p> <p>Machine Learning and Data Science (EQ2415)</p>			<p><u>Theory and Methodology of Science with Applications (Natural and Technological Science) (AK2036)</u></p> <p>IT Management with Enterprise Architecture I (EH2770)</p>	<p>Applied Antenna Theory (EI2400)</p> <p>Queuing Theory and Teletraffic Systems (EP2200)</p> <p>Principles of Wireless Sensor Networks (EP2700)</p>	<p>Building Networked Systems Security (EP2520)</p>			<p>Project in Multimedia Processing and Analysis (EQ2445)</p>

				<p>Industrial Management , Basic Course (ME1003)</p> <p>The Sustainable Information and Network Engineer (EQ2222)</p> <p>Leadership in Cross-Cultural and Industrial Contexts (ME2089)</p>	<p>Wireless Networks (EP2950)</p> <p>Network Programming (ID1212)</p> <p>Software Defined Networking (SDN) and Network Functions Virtualization (NFV) (IK2220)</p>				
Teaching methods									
KTH Machine Learning	<p><u>Program Integrating Course in Machine Learning (DD2301)</u></p> <p>Artificial Intelligence (DD2380)</p> <p>Machine Learning (DD2421)</p> <p>Machine Learning, Advanced Course (DD2434)</p> <p>Deep</p>	<p>Introduction to Robotics (DD2410)</p> <p>Research project in Robotics, Perception and Learning (DD2411)</p> <p>Project Course in Robotics and Autonomous Systems (DD2419)</p> <p><u>Probabilistic Graphical Models (DD2420)</u></p> <p>Artificial Neural Networks and Deep Architectures (DD2437)</p>				Computer Security (DD2395)		<p>Visualization (DD2257)</p> <p>Image Analysis and Computer Vision (DD2423)</p> <p><u>Deep Learning in Data Science (DD2424)</u></p> <p><u>Visualization (DD2257)</u></p>	

	Learning, Advanced Course (DD2412)	Artificial Intelligence and Multi Agent Systems (DD2438) Pattern Recognition and Machine Learning (EQ2341)							
Teaching methods									
KTH Security and Cloud Computing (Joint Erasmus+)	<u>CS-E4640</u> Big Data Platforms				<u>II2302</u> Sensor Based Systems IK2510 Wireless Networks IK2511 Project in Wireless Networks	<u>CS-C3130</u> Information Security <u>CS-E4350</u> Security Engineering <u>CS-E4300</u> Network Security <u>CS-E4160</u> Laboratory Works in Networking and Security <u>CS-E4330</u> Special Course in Information Security	<u>CS-E4190</u> Cloud Software and Systems EP2300 Management of Networks and Networked Systems <u>EP2500</u> Networked Systems Security		
Teaching methods									
KTH Software Engineering of Distributed Systems	Distributed Artificial Intelligence and Intelligent Agents				Distributed Systems, Basic Course (ID2201)				Programming of Interactive Systems

<p>KTH</p> <p>Engineering Design</p> <p>School of Industrial Engineering and Management</p>		<p>Dynamics and Motion Control (MF2007)</p> <p>Automatic Control, General Course (EL1000)</p>	<p>Modelling of Dynamical Systems (EL2820)</p>						<p><u>CAD 3D-modelling and Visualization (MF2019)</u></p>
<p>Teaching methods</p>									
<p>KTH</p> <p>Industrial Management</p> <p>School of Industrial Engineering and Management</p>				<p><u>Project Management : Leadership and Control (ME2016)</u></p> <p><u>Operations and Supply Chain Strategy (ME2065)</u></p> <p><u>Strategy and Industrial Marketing (ME2066)</u></p> <p>Industrial Transformation and Technical Changes (ITTEC) (ME2067)</p> <p><u>Perspectives on Industrial Management (ME2501)</u></p> <p><u>Managing Research</u></p>					

